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# APPLICATION
# FOR
# UNITED STATES
# LETTERS PATENT

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**FOR:** POWER TOOL

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# POWER TOOL

## BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates to a power tool such as an impact screwdriver and an oil pulse screwdriver.

2. Description of the Related Art

A conventional power tool will be described with reference to Fig. 8. Fig. 8 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool for imparting a rotational force and a striking force to an end tool 20 such as a bit. Generally, a motor 2, serving as a drive source, a speed reduction mechanism portion 8 for transmitting a rotational power of a pinion 4 which is an output shaft of the motor 2, a spindle 14 for transmitting the rotational power from the speed reduction mechanism portion 8, a hammer 15, which is rotatable and movable in a direction of the axis of rotation through steel balls 16 inserted in cam grooves 14a formed in the spindle 14, an anvil 17, having anvil claws 17b which are struck by a plurality of hammer claws 15b, provided at the hammer 15, to be rotated, the end tool 20, releasably attached to the anvil 17, and a spring 12, normally urging the hammer 15 toward the anvil 17, are received within a housing 1 and a casing 10 which form a impact tool body. The speed reduction mechanism portion includes a fixed gear

support jig 7, which has rotation stoppers, and is supported within the housing 1, a fixed gear 6, planetary gears 8, and the spindle 14, and further includes needle pins 9 serving as rotation shafts for the planetary gears 8, and the gears 8 and the needle pins 9 form part of the spindle 14. One end the spindle 14 is borne by a bearing 11, and the other end thereof is rotatably supported in a central hole 17a in the anvil 17 rotatably supported by a metal bearing 18.

A trigger switch 3 is operated to supply electric power to the motor 2 to drive this motor 2 for rotation, and then the rotational power of this motor 2 is transmitted to the planetary gears 8 through the pinion 4 connected to the distal end of the motor 2, and the rotational power of the pinion 4 is transmitted to the spindle 14 through the needle pins 9 by the meshing engagement of the planetary gears 8 with the fixed gear 6, and the rotational force of the spindle 14 is transmitted to the hammer 15 through the steel balls 16 each disposed between the cam groove 14a of the spindle 14 and a cam groove 15a of the hammer 15, and the hammer claw 15b of the hammer 15, urged forward (toward the bit) by the spring 12 provided between the hammer 5 and the planetary gears 8 of the spindle 14, strikes the anvil claw 17b of the anvil 17 as a result of the rotation, thereby producing a pulse-like impact which is imparted to a screw, a nut or the like to be tightened by the end tool 20. After the striking operation, the striking

energy of the hammer 15 decreases, and the torque of the anvil 17 decreases, whereupon the hammer 15 rebounds from the anvil 17, and therefore the hammer 15 moves toward the planetary gears 8 along the cam grooves 15a and 14a. Before the hammer 15 impinges on a stopper 22, the hammer 15 is again moved back along the cam grooves 15a and 14a toward the anvil 17 by the compressive force of the spring 12, and the hammer 15 is accelerated by the rotation of the spindle 14 through the steel balls 16 each disposed between the cam groove 14a of the spindle 14 and the cam groove 15a of the hammer 15. During the reciprocal movement of the hammer 15 toward the stopper 22 along the cam grooves 14a and 15a, the spindle 14 continues to rotate, and therefore in the case where the hammer claw 15b of the hammer 15 moves past the anvil claw 17b of the anvil 17, and again strikes the anvil claw 17b, the hammer 15, when rotated through 180°, strikes the anvil 17. Thus, the anvil 17 is repeatedly struck by the axial movement and rotation of the hammer 15, and by doing so, the screw or the like is tightened while continuously imparting the impact torque thereto.

As described above, by the rotation and axial movement of the hammer, the hammer claw of the hammer was caused to repeatedly impinge on the anvil claw of the anvil, thereby imparting the impact torque to the anvil. However, in the case of driving the screw into a hard wooden material or in the case of fastening a bolt to an iron plate, the rebounding force,

produced by the anvil upon impingement, was very large, so that the hammer was moved back until it impinged on the stopper provided at the spindle. Therefore, each time the hammer impinged on the stopper, there was exerted a force to instantaneously lock (press) the rotating spindle. Therefore, even when the locking effect acted on the spindle, a large load (rotational impact force) was exerted on the gear portions of the speed reduction mechanism portion, provided between the motor and the spindle, since the pinion of the motor was rotating, and as a result there was encountered a problem that the speed reduction mechanism portion and the housing, holding this speed reduction mechanism portion, were damaged. And besides, a locking effect acted on the spindle when the hammer claw impinged on the anvil claw, and therefore there was encountered a problem that he speed reduction mechanism portion and the housing, holding this speed reduction mechanism portion, were damaged.

SUMMARY OF THE INVENTION

This invention seeks to provide a power tool of a long lifetime which is enhanced in durability by overcoming the above problems and by damping a rotational impact force acting on a speed reduction mechanism portion.

The above object has been achieved by a power tool comprising a motor serving as a drive source, a speed reduction

mechanism portion for transmitting a rotational power of the motor, a striking mechanism portion for converting the rotational power of the speed reduction mechanism portion into a striking force, and an end tool for outputting the striking force and a rotational force through the striking mechanism portion; characterized in that there is provided an impact damping mechanism for damping an impact in a direction of rotation of the speed reduction mechanism portion.

## BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool of the present invention.

Fig. 2 is an exploded view showing a first embodiment of an impact damping mechanism mounted on the impact tool of Fig. 1.

Fig. 3 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool of the present invention.

Fig. 4 is an exploded view showing a second embodiment of an impact damping mechanism mounted on the impact tool of Fig. 3.

Fig. 5 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool of the present invention.

Fig. 6 is an exploded view showing a third embodiment of an impact damping mechanism mounted on the impact tool of Fig. 5.

Fig. 7 is a perspective appearance view showing a fourth embodiment of an impact damping mechanism mounted on an impact tool of the invention.

Fig. 8 is a partly-omitted, vertical cross-sectional, side-elevational view showing a conventional impact tool.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An impact tool of this embodiment will now be described with reference to Figs. 1 to 6. Figs. 1 and 2 show a first embodiment, and Fig. 1 is a partly-omitted, vertical cross-sectional, side-elevational view showing the impact tool, and Fig. 2 is an exploded view showing an impact damping mechanism mounted on the impact tool. In Figs. 1 and 2, a motor 2, serving as a drive source, a speed reduction mechanism portion 8 for transmitting a rotational power of a pinion 4 which is an output shaft of the motor 2, a spindle 14 for transmitting the rotational power from the speed reduction mechanism portion 8, a hammer 15, which is rotatable and movable in a direction of the axis of rotation through steel balls 16 inserted in cam grooves 14a formed in the spindle 14, an anvil 17, having anvil claws 17b which are struck by a plurality of hammer claws 15b, provided at the hammer 15, to be rotated,

an end tool 20, releasably attached to the anvil 17, and a spring 12, normally urging the hammer 15 toward the anvil 17, are received within a housing 1 and a casing 10 which form a impact tool body of the impact tool. A striking mechanism portion mainly comprises the spring 12, the spindle 14, the hammer 15, the steel balls 16 and the anvil 17. The speed reduction mechanism portion includes a fixed gear support jig 7, which has rotation stoppers, and is supported against rotation within the housing 1, a fixed gear 6, planetary gears 8, and the spindle 14, and further includes needle pins 9 serving as rotation shafts for the planetary gears 8, and the gears 8 and the needle pins 9 form part of the spindle 14. One end the spindle 14 is borne by a bearing 11, and the other end thereof is rotatably supported in a central hole 17a in the anvil 17 rotatably supported by a metal bearing 18.

A trigger switch 3 is operated to supply electric power to the motor 2 to drive this motor 2 for rotation, and then the rotational power of this motor 2 is transmitted to the planetary gears 8 through the pinion 4 connected to the distal end of the motor 2, and the rotational power of the pinion 4 is transmitted to the spindle 14 through the needle pins 9 by the meshing engagement of the planetary gears 8 with the fixed gear 6, and the rotational force of the spindle 14 is transmitted to the hammer 15 through the steel balls 16 each disposed between the cam groove 14a of the spindle 14 and a

cam groove 15a of the hammer 15, and the hammer claw 15b of the hammer 15, urged forward (toward the bit) by the spring 12 provided between the hammer 5 and the planetary gears 8 of the spindle 14, strikes the anvil claw 17b of the anvil 17 as a result of the rotation, thereby producing a pulse-like impact which is imparted to a screw, a nut or the like to be tightened by the end tool 20. After the striking operation, the striking energy of the hammer 15 decreases, and the torque of the anvil 17 decreases, whereupon the hammer 15 rebounds from the anvil 17, and therefore the hammer 15 moves toward the planetary gears 8 along the cam grooves 15a and 14a. Before the hammer 15 impinges on a stopper 22, the hammer 15 is again moved back along the cam grooves 15a and 14a toward the anvil 17 by the compressive force of the spring 12, and the hammer 15 is accelerated by the rotation of the spindle 14 through the steel balls 16 each disposed between the cam groove 14a of the spindle 14 and the cam groove 15a of the hammer 15. During the reciprocal movement of the hammer 15 toward the stopper 22 along the cam grooves 14a and 15a, the spindle 14 continues to rotate, and therefore in the case where the hammer claw 15b of the hammer 15 moves past the anvil claw 17b of the anvil 17, and again strikes the anvil claw 17b, the hammer 15, when rotated through 180°, strikes the anvil 17. Thus, the anvil 17 is repeatedly struck by the axial movement and rotation of the hammer 15, and by doing so, the screw or the like is tightened while

continuously imparting the impact torque thereto.

The impact damping mechanism is mounted on the thus operating impact tool, and as shown in Fig. 2, this impact damping mechanism comprises the fixed gear support jig 7b, which has the rotation stoppers 25a the direction of rotation of which is fixed within the housing 1, and has a circular outer peripheral portion, and has its center held in a predetermined position relative to the housing 1, the fixed gear 6a, which is held within an inner periphery of the fixed gear support jig 7a so as to rotate very slightly, with its center held in a predetermined position, and impact damping members 5a and 5b which are inserted in holes 7b, formed in the fixed gear support jig 7a, and engage projections 6b formed on a side surface of the fixed gear 6a.

With this impact damping mechanism, when the hammer 15 moves toward the planetary gears 8 along the cam grooves 15a and 14a, and impinges on the stopper 22, the pinion 14 is always rotating, but the claws 6b of the fixed gear 6 compress the impact damping members 5a and 5b, and therefore the impact force in the rotational direction can be damped by the very slight rotation of the fixed gear 6a. In this construction, the impact damping members 5a and 5b are provided in a gap between the bearing 11, which is the rear bearing for the spindle 14, and the housing 1, and therefore the damping mechanism can be provided effectively without increasing the overall length of

the tool. And besides, the impact damping members 5a and 5b are arranged in the direction of the rotational load, and are provided on opposite sides of the projection 6b, respectively, and therefore can meet the normal and reverse rotation of the motor 2 and the vibration of the load. The number of the projections 6b is not limited to two as in the illustrated example, but at least one projection need only to be provided.

Figs. 3 and 4 show a second embodiment, and Fig. 3 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool, and Fig. 4 is an exploded view showing an impact damping mechanism mounted on the impact tool. The impact damping mechanism is mounted on the impact tool shown in Fig. 3, and in this impact damping mechanism, projections 6d are formed on an outer surface of a fixed gear 6c as shown in Fig. 4, and holes 7d are formed respectively in those portions of a fixed gear support jig 7c (which is mounted within a housing 1) corresponding respectively to the projections 6d on the outer surface of the fixed gear 6c, and impact damping members 5c and 5d are inserted in these holes 7d.

In this impact damping mechanism, the fixed gear 6c is combined with the fixed gear support jig 7c in such a manner that the projection 6d of the fixed gear 6c is inserted between the impact damping members 5c and 5d. Therefore, the load is supported at a more radially-outward side of the fixed gear 6c as compared with the impact damping mechanism shown in Figs.

1 and 2, and therefore the load can be damped more effectively. Although the outer diameter of the fixed gear support jig 7c and the size of the housing 1 are slightly increased, the sufficient effect can be obtained.

Figs. 5 and 6 show a third embodiment, and Fig. 5 is a partly-omitted, vertical cross-sectional, side-elevational view showing an impact tool, and Fig. 6 is an exploded view showing an impact damping mechanism mounted on the impact tool. The impact damping mechanism is mounted on the impact tool shown in Fig. 5, and in this impact damping mechanism, a fixed gear 6 and a fixed gear support jig 7e are fixedly secured to each other as shown in Fig. 6, and impact damping members 5e and 5f are provided respectively on opposite sides of each of projections 7f which are rotation stoppers for preventing the rotation of the fixed gear support jig 7e relative to a housing 1.

In this impact damping mechanism, that side of each impact damping member 5e, 5f, facing in the same direction as the projection 7f, is held by a rib 1a of the housing 1 of the body, and besides the impact damping members 5e and 5f are provided between a bearing 11 and the housing 1, and therefore a rotational impact force can be damped without increasing the overall length.

Fig. 7 shows a fourth embodiment, and is a perspective appearance view showing an impact damping mechanism mounted

on an impact tool. In the thus mounted impact damping mechanism, as shown in Fig. 7, a fixed gear 6 and a fixed gear support jig 7g are fixedly secured to each other, and projections 7h are formed on an outer surface of the fixed gear support jig 7g, and each of impact damping members 5g and 5h is arranged between that side of the projection 7h, facing in the direction of rotation, and a rib (not shown) of a housing 1.

In this impact damping mechanism, the load is supported at a more radially-outward side as compared with the impact damping mechanism shown in Fig. 6, and therefore the load can be damped more effectively as compared with the mechanism of Fig. 6. Although the outer diameter of the fixed gear support jig 7g and the size of the housing 1 are slightly increased, the sufficient effect can be obtained.

By combining the above-mentioned impact damping mechanisms, the rotational impact between the fixed gear 6 and the housing 1 can be further reduced, and preferably any one of various vibration-insulating rubber, soft plastics materials, felts and so on, which have a damping effect, is used as the impact damping material 5.

In the present invention, the rotational impact force of the speed reduction mechanism portion, produced by the abrupt acceleration of the impact mechanism portion, is damped, and by doing so, the jig, supporting the speed reduction

mechanism portion, or the housing is enhanced in durability, so that the lifetime of the tool can be increased. And besides, the load, acting on the various portions, is reduced, and therefore materials, of which the various portions are made, can be changed to inexpensive, low-grade materials. By inserting the impact damping members between the bearing of the impact mechanism portion or the bearing of the speed reduction mechanism portion and the housing, a more compact-size design can be achieved.

By damping the abrupt rotational impact force, the vibration of the housing or the vibration of the motor, connected to the speed reduction mechanism portion, is reduced, and the operator, holding the impact tool, is less fatigued even when he uses the tool for a long period of time, and therefore the efficiency of the operation can be enhanced, and noises, produced by the vibration, can be reduced.